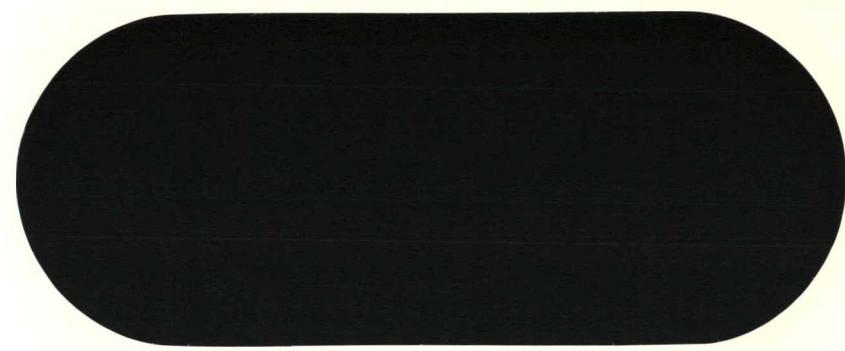




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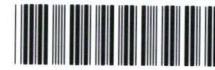
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WA 2917
ANNUAL PROGRESS REPORT

Interim Liquid Hydrocarbon Recovery System

Terminal 91
Seattle, Washington

FILE COPY
3/5/1992

Prepared for:

Pacific Northern Oil

Converse Project No. 89-45527-04

March 5, 1992



INTRODUCTION

The following report documents the progress of the liquid hydrocarbon recovery system currently operating at the Terminal 91 facility located in Seattle, Washington. The site location is shown on Figure 1 and the site layout is presented on Figure 2. This report covers the period from January 15, 1991 through February 7, 1992.

Results of previous investigations (Hart Crowser, September 11, 1989; Converse GES, July 5, 1990) at the Terminal 91 facility indicated the presence of floating diesel hydrocarbons on the water table in the vicinity of the pipeline operated by Pacific Northern Oil (PNO). The spill area is located south of the guard shack at the West Garfield Street entrance, and west of the retaining wall and Lake Jacobs (Figure 2). As an immediate response to control the migration of the diesel product and removal of free product, an interim product extraction system was implemented at the PNO pipeline site.

SYSTEM DESCRIPTION

The liquid hydrocarbon recovery system has operated as a skimming system, cycling on 1 minute in every 15 minutes, pumping 20 to 30 gallons total fluids per day. The system is maintained in a skimming mode to maintain natural hydraulic gradients at the nearby Chempro facility. The Chempro facility is currently conducting a RCRA Facilities Investigation and Corrective Action Study. To date, the system has removed approximately 30 gallons of liquid hydrocarbons.

Liquid hydrocarbon recovery is accomplished with an all-pneumatic system total fluids pump installed in a 6-inch-diameter extraction well (EW-1) and a 2-inch-diameter monitoring well (MW-3) (Figure 2). The pump intake lines are equipped with floats designed to maintain the intake at the top of the air/liquid hydrocarbon interface. A timer controls the pump, cycling on one minute in every fifteen. Topside separation of recovered liquid hydrocarbons from water is accomplished with a Quantek coalescing plate oil/water separator. Treated groundwater effluent is discharged to the Municipality of

Metropolitan Seattle under Permit No. 7597. Recovered liquid hydrocarbons are stored on-site in 55-gallon drums. The recovery system began operation on January 15, 1991. Since that time approximately 47,760 gallons of total fluids have been recovered and treated by the oil/water separator as of February 7, 1992.

PERFORMANCE MONITORING

The following monitoring schedule has been maintained during the past year to measure the effectiveness of the liquid hydrocarbon extraction system:

- Periodic Liquid Hydrocarbon Thickness Measurements
- Quarterly Groundwater Sampling
- Weekly Liquid Hydrocarbon Storage Drum Measurements
- Quarterly Groundwater Level Measurements

Liquid Hydrocarbon Thickness Measurements

Apparent liquid hydrocarbon thickness is measured periodically in wells EW-1, MW-3 and MW-102. The thickness of liquid hydrocarbons as measured in EW-1, MW-3, and MW-102 is an apparent thickness rather than a true or formation thickness¹. Tables 1, 2 and 3 provide tabulated data from these three wells, respectively. No liquid hydrocarbons have been measured in wells MW-2, MW-6, MW-11, and MW-103, immediately adjacent to the site (Figure 2). The largest measurable amount of liquid hydrocarbons occurred in the recovery well (EW-1) on January 22, 1991 at 1.02 feet, and on March 5, 1991 in well MW-3 at 0.90 foot. Figures 3 through 5 provide a graphical representation of liquid hydrocarbon thickness versus time for wells EW-1, MW-3 and MW-102, respectively. In general, it appears that the thickness of liquid hydrocarbons has decreased throughout time in all three of the wells. A recent high

¹Apparent thickness as measured in a monitoring well is generally greater than true or formation thickness because of the absence of a capillary fringe. The relative difference between apparent and true hydrocarbon thickness is also related to formation grain size and the specific gravity of the hydrocarbons.

measurement of 0.75 foot of liquid hydrocarbons was observed in MW-3 on February 3, 1992.

Quarterly Groundwater Sampling

Monitoring wells MW-2, MW-6, and MW-102 have been sampled on a quarterly basis (four times a year) to assess the concentration of total petroleum hydrocarbons (TPH) dissolved in the groundwater. Samples were analyzed by method WTPH-D, which is able to quantify the extractable range of hydrocarbons associated with diesel fuel. Table 4 presents the results of the quarterly sampling results for the time period of October 1989 through January 1992. Concentrations of TPH dissolved in the groundwater have remained stable in monitoring well MW-2, decreased in MW-6, and have increased in the downgradient direction in well MW-102. The current Washington State Department of Ecology, Model Toxics Control Act, Method A groundwater cleanup level for TPH is 1 mg/l. TPH concentrations in quarterly groundwater samples collected to date have all been elevated above the cleanup level.

Drum Measurements

Measurements of two liquid hydrocarbon storage drums (north drum and south drum) have occurred on a weekly basis since April 1991. The drums collect liquid hydrocarbons and some water that have been segregated in the oil/water separator. Tables 5 and 6 provide the results of the measurements for the time period April 29, 1991 through February 3, 1992. Figures 6 and 7 show a graphical representation of the number of gallons of liquid hydrocarbon recovered versus time. To date, the recovery system has removed approximately 30 gallons of liquid hydrocarbons.

Groundwater Level Measurements

Groundwater contour plots from groundwater level measurements prior to system operation are shown on Figures 8 and 9 for July and December, 1990. The groundwater contours indicate a groundwater migration direction approximately south-southeast. Groundwater contour plots from groundwater level measurements since the system started operation are shown on Figures 10 through 12 for April 30, 1991; August 29, 1991; and January 2, 1992; respectively. Not

all wells were measured in each round due to parked vehicles over wells. Figures 9 and 12 permit a comparison of groundwater flow prior to and after the start-up of the recovery system for winter conditions. Aside from minor water level changes with no consistent increase or decrease between individual wells, no significant variation in site groundwater conditions are indicated by the contour plots.

SYSTEM MAINTENANCE AND IMPROVEMENTS

System maintenance occurs on a weekly basis and includes the following activities:

- Check Oil Level in Air Compressor and Change as Necessary
- Check Level in Oiler and Add if Necessary
- Change Moisture Desiccant as Necessary
- Drain Moisture from Air Compressor Tank
- Bleed Moisture Separator Filter
- Check Air Intake Filter on Air Compressor
- Check and Calibrate LEL Sensor

Since the system has become operational several improvements and modifications have occurred. The following chronology lists the system changes that have occurred to date:

- | | |
|----------|---|
| 6/20/91 | Ingersol Rand Air Compressor Failed, Install New Dayton Air Compressor |
| 6/21/91 | Removed QED Pulse Pump from EW-1, Install Skimmer Float and Pneumatic Diaphragm Pump in EW-1 and MW-3 |
| 7/2/91 | Install New Solenoid Control Valve |
| 9/4/91 | Reset Timer to pump 30 minutes every 4 hours |
| 10/1/91 | Reset Timer to pump 30 minutes every 3 hours |
| 10/8/91 | Install Rebuilt Ingersol Rand Air Compressor |
| 10/25/91 | Install Rebuilt Dayton Air Compressor |
| 11/20/91 | Install new Timer program to pump for 1 minute every 15 minutes |

Table 7 presents the daily effluent discharge records since the system has been operational. Approximately 47,760 gallons of total fluids have been treated by the system since February 7, 1992.

TABLE 1
PACIFIC NORTHERN OIL
TERMINAL 91
GROUNDWATER ELEVATION MEASUREMENTS

RECOVERY WELL EW-1

Date	Time	Elevation (Feet)	Depth To Product (Feet)	Depth To Water (Feet)	Product Thickness (Feet)	Water Elevation (Feet)
04-Sep-90	07:49	17.52	9.11	9.14	0.03	8.41
03-Dec-90	10:03	17.52	8.27	8.28	0.01	9.25
04-Dec-90	08:20	17.52	8.04	8.04	0.00	9.48
05-Dec-90	09:42	17.52	8.14	8.14	0.00	9.38
16-Jan-91	12:30	17.52	8.60	8.62	0.02	8.92
17-Jan-91	07:40	17.52	8.85	8.86	0.01	8.67
18-Jan-91	12:59	17.52	9.09	9.18	0.09	8.42
21-Jan-91	10:10	17.52	8.87	8.90	0.03	8.65
22-Jan-91	08:54	17.52	8.85	9.87	1.02	8.53
22-Jan-91	13:55	17.52	8.95	8.95	0.00	8.57
23-Jan-91	12:51	17.52	8.95	8.95	0.00	8.57
24-Jan-91	14:20	17.52	8.87	8.87	0.00	8.65
31-Jan-91	13:44	17.52	9.02	9.02	0.00	8.50
13-Feb-91	13:16	17.52	8.20	8.58	0.38	9.27
20-Feb-91	14:08	17.52	8.55	8.81	0.26	8.93
21-Feb-91	09:45	17.52	8.98	9.10	0.12	8.52
25-Feb-91	12:14	17.52	8.73	8.84	0.11	8.77
27-Feb-91	14:45	17.52	8.75	8.80	0.05	8.76
05-Mar-91	09:24	17.52	8.25	9.00	0.75	9.17
12-Mar-91	17:50	17.52	8.77	9.00	0.23	8.72
14-Mar-91	14:00	17.52	8.30	8.55	0.25	9.18
18-Mar-91	17:05	17.52	8.90	9.00	0.10	8.61
27-Mar-91	14:00	17.52	8.80	8.81	0.01	8.72
29-Mar-91	11:00	17.52	9.21	9.21	0.00	8.31
30-Apr-91	07:38	17.52	9.24	9.40	0.16	8.26
21-Jun-91	09:27	17.52	9.42	9.70	0.28	8.06
19-Jul-91	10:04	17.52	9.31	9.33	0.02	8.21
26-Jul-91	09:55	17.52	9.39	9.40	0.01	8.13
02-Aug-91	13:05	17.52	9.25	9.25	0.00	8.27
05-Aug-91	13:50	17.52	9.19	9.20	0.01	8.33
16-Aug-91	15:23	17.52	9.11	9.11	0.00	8.41
29-Aug-91	10:50	17.52	9.02	9.02	0.00	8.50
04-Sep-91	09:35	17.52	9.38	9.43	0.05	8.13
10-Sep-91	09:33	17.52	9.03	9.07	0.04	8.48
24-Sep-91	11:37	17.52	9.47	9.77	0.30	8.01
30-Sep-91	15:49	17.52	9.25	9.28	0.03	8.27
04-Oct-91	14:09	17.52	9.20	9.23	0.03	8.32
16-Oct-91	13:27	17.52	9.06	9.16	0.10	8.45
21-Oct-91	14:43	17.52	9.17	9.30	0.13	8.33
28-Oct-91	11:20	17.52	8.89	9.00	0.11	8.61

TABLE 1
PACIFIC NORTHERN OIL
TERMINAL 91
GROUNDWATER ELEVATION MEASUREMENTS

RECOVERY WELL EW-1

Date	Time	Elevation (Feet)	Depth To Product (Feet)	Depth To Water (Feet)	Product Thickness (Feet)	Water Elevation (Feet)
06-Nov-91	16:18	17.52	8.96	9.03	0.07	8.55
12-Nov-91	11:56	17.52	8.85	8.91	0.06	8.66
18-Nov-91	12:13	17.52	8.7	8.78	0.08	8.81
25-Nov-91	11:33	17.52	8.43	8.45	0.02	9.09
09-Dec-91	13:18	17.52	8.54	8.57	0.03	8.98
16-Dec-91	14:16	17.52	8.67	8.67	0.00	8.85
27-Dec-91	12:36	17.52	8.37	8.37	0.00	9.15
30-Dec-91	15:00	17.52	8.37	8.37	0.00	9.15
06-Jan-92	14:42	17.52	8.29	8.29	0.00	9.23
13-Jan-92	11:42	17.52	8.33	8.33	0.00	9.19
24-Jan-92	11:14	17.52	8.29	8.29	0.00	9.23
27-Jan-92	14:42	17.52	8.22	8.22	0.00	9.30
03-Feb-92	13:34	17.52	7.73	7.73	0.00	9.79

NOTE: Groundwater elevations are corrected for the density
of diesel hydrocarbons (multiplier = 0.86)

TABLE 2
PACIFIC NORTHERN OIL
TERMINAL 91
GROUNDWATER ELEVATION MEASUREMENTS

MONITORING WELL MW-3

Date	Time	Elevation (Feet)	Depth To Product (Feet)	Depth To Water (Feet)	Product Thickness (Feet)	Water Elevation (Feet)
10-Jul-90	00:00	17.70	9.10	9.32	0.22	8.57
11-Jul-90	00:00	17.70	9.10	9.32	0.22	8.57
05-Dec-90	10:02	17.70	8.32	8.42	0.10	9.37
06-Dec-90	13:22	17.70	8.32	8.52	0.20	9.35
16-Jan-91	15:31	17.70	8.51	9.16	0.65	9.10
17-Jan-91	07:40	17.70	8.54	9.12	0.58	9.08
18-Jan-91	13:05	17.70	8.65	9.09	0.44	8.99
21-Jan-91	10:18	17.70	8.75	9.00	0.25	8.92
22-Jan-91	09:05	17.70	8.77	9.20	0.43	8.87
22-Jan-91	15:15	17.70	8.95	9.46	0.51	8.68
23-Jan-91	12:53	17.70	8.80	9.28	0.48	8.83
24-Jan-91	14:27	17.70	8.83	9.29	0.46	8.81
31-Jan-91	13:48	17.70	8.94	9.41	0.47	8.69
13-Feb-91	13:21	17.70	8.30	8.87	0.57	9.32
20-Feb-91	14:28	17.70	8.43	8.82	0.39	9.22
21-Feb-91	09:48	17.70	8.49	8.80	0.31	9.17
25-Feb-91	12:18	17.70	8.64	8.99	0.35	9.01
27-Feb-91	14:25	17.70	8.65	9.00	0.35	9.00
05-Mar-91	09:28	17.70	8.10	9.00	0.90	9.47
12-Mar-91	17:47	17.70	8.42	9.15	0.73	9.18
14-Mar-91	13:50	17.70	8.32	9.02	0.70	9.28
18-Mar-91	17:00	17.70	8.63	9.30	0.67	8.98
27-Mar-91	14:00	17.70	8.68	9.08	0.40	8.96
30-Apr-91	07:43	17.70	8.92	9.42	0.50	8.71
21-Jun-91	09:30	17.70	9.42	9.49	0.07	8.27
26-Jul-91	09:52	17.70	9.37	9.43	0.06	8.32
02-Aug-91	13:08	17.70	9.27	9.27	0.00	8.43
05-Aug-91	13:56	17.70	9.33	9.42	0.09	8.36
16-Aug-91	15:27	17.70	9.14	9.14	0.00	8.56
29-Aug-91	10:47	17.70	9.16	9.22	0.06	8.53
04-Sep-91	09:40	17.70	9.32	9.68	0.36	8.33
10-Sep-91	09:38	17.70	9.19	9.35	0.16	8.49
24-Sep-91	11:39	17.70	9.48	9.53	0.05	8.21
30-Sep-91	15:54	17.70	9.11	9.14	0.03	8.59
04-Oct-91	14:13	17.70	9.37	9.55	0.18	8.30
16-Oct-91	13:32	17.70	9.30	9.30	0.00	8.40
21-Oct-91	14:46	17.70	9.35	9.39	0.04	8.34
28-Oct-91	11:13	17.70	9.10	9.10	0.00	8.60
06-Nov-91	16:12	17.70	9.16	9.16	0.00	8.54
12-Nov-91	11:51	17.70	9.03	9.03	0.00	8.67

TABLE 2
PACIFIC NORTHERN OIL
TERMINAL 91
GROUNDWATER ELEVATION MEASUREMENTS
MONITORING WELL MW-3

Date	Time	Elevation (Feet)	Depth To Product (Feet)	Depth To Water (Feet)	Product Thickness (Feet)	Water Elevation (Feet)
18-Nov-91	12:09	17.70	8.86	8.96	0.10	8.83
25-Nov-91	11:41	17.70	8.63	8.63	0.00	9.07
03-Dec-91	13:02	17.70	8.85	8.85	0.00	8.85
09-Dec-91	13:23	17.70	8.67	8.67	0.00	9.03
16-Dec-91	14:21	17.70	8.80	8.83	0.03	8.90
27-Dec-91	12:42	17.70	8.58	8.65	0.07	9.11
30-Dec-91	15:09	17.70	8.51	8.51	0.00	9.19
06-Jan-92	14:37	17.70	8.4	8.55	0.15	9.28
13-Jan-92	11:49	17.70	8.52	8.64	0.12	9.16
24-Jan-92	11:18	17.70	8.44	8.44	0.00	9.26
27-Jan-92	14:47	17.70	8.28	8.51	0.23	9.39
03-Feb-92	13:38	17.70	7.24	7.99	0.75	10.35

NOTE: Groundwater elevations are corrected for the density
of diesel hydrocarbons (multiplier = 0.86).

TABLE 3
PACIFIC NORTHERN OIL
TERMINAL 91
GROUNDWATER ELEVATION MEASUREMENTS

MONITORING WELL MW-102

Date	Time	Elevation (Feet)	Depth To Product (Feet)	Depth To Water (Feet)	Product Thickness (Feet)	Water Elevation (Feet)
10-Jul-90	00:00	17.50	9.24	9.24	0.00	8.26
11-Jul-90	00:00	17.50	9.25	9.25	0.00	8.25
30-Apr-91	11:50	17.50	9.38	9.38	0.00	8.12
29-Aug-91	12:05	17.50	9.42	9.42	0.00	8.08
10-Sep-91	09:23	17.50	9.29	9.41	0.12	8.19
30-Sep-91	16:05	17.50	9.33	9.46	0.13	8.15
04-Oct-91	14:25	17.50	9.48	9.68	0.20	7.99
16-Oct-91	13:12	17.50	9.35	9.42	0.07	8.14
16-Oct-91	13:18	17.50	9.35	9.45	0.10	8.14
21-Oct-91	14:32	17.50	9.46	9.58	0.12	8.02
28-Oct-91	11:36	17.50	9.16	9.19	0.03	8.34
06-Nov-91	16:30	17.50	9.23	9.32	0.09	8.26
12-Nov-91	12:11	17.50	9.13	9.17	0.04	8.36
18-Nov-91	12:38	17.50	8.95	8.97	0.02	8.55
25-Nov-91	11:47	17.50	8.72	8.72	0.00	8.78
09-Dec-91	13:11	17.50	8.79	8.79	0.00	8.71
27-Dec-91	12:53	17.50	8.66	8.66	0.00	8.84
30-Dec-91	15:04	17.50	8.57	8.57	0.00	8.93
06-Jan-91	14:48	17.50	8.45	8.46	0.01	9.05
13-Jan-91	12:00	17.50	8.63	8.63	0.00	8.87
24-Jan-91	11:25	17.50	8.57	8.57	0.00	8.93
27-Jan-91	14:54	17.50	8.39	8.39	0.00	9.11
03-Feb-91	13:43	17.50	7.87	7.87	0.00	9.63

NOTE: Groundwater elevations are corrected for the density
of diesel hydrocarbons (multiplier = 0.86).

TABLE 4
PACIFIC NORTHERN OIL
TERMINAL 91
GROUNDWATER QUALITY DATA

TOTAL PETROLEUM HYDROCARBONS AS DIESEL (TPH-D)

Date	Monitoring Well		
	MW-2	MW-6	MW-102
30-Oct-89	15.0	13.0	
06-Dec-89		2.8	6.9
07-Dec-89	3.0		
19-Dec-90	2.5 U	120.0	7.8
30-Apr-91	10.0	260.0	3.7
29-Aug-91	17	32	29
02-Jan-92	10	120	36

All results are in milligrams per liter (mg/L) or ppm

U – Indicates compound was analyzed for but not detected at the given detection limit.

MTCA Method A Groundwater Cleanup Standard for TPH-D is 1 mg/L.

TABLE 5
PACIFIC NORTHERN OIL
TERMINAL 91

PNO NORTH DRUM CAPACITY READINGS

Date	Inches Water	Inches Product	Inches Total	Gallons Water	Gallons Product	Gallons Total
29-Apr-91	4.000	6.750	10.750	6.84	11.55	18.40
01-May-91	4.250	6.000	10.250	7.27	10.27	17.54
03-May-91	5.000	5.500	10.500	8.56	9.41	17.97
06-May-91	4.875	4.875	9.750	8.34	8.34	16.68
08-May-91	4.875	4.875	9.750	8.34	8.34	16.68
10-May-91	4.500	6.000	10.500	7.70	10.27	17.97
12-May-91	4.875	5.000	9.875	8.34	8.56	16.90
16-May-91	4.500	5.500	10.000	7.70	9.41	17.11
20-May-91	4.875	5.000	9.875	8.34	8.56	16.90
21-May-91	4.875	5.250	10.125	8.34	8.98	17.33
28-May-91	5.000	5.500	10.500	8.56	9.41	17.97
31-May-91	4.500	6.500	11.000	7.70	11.12	18.82
21-Jun-91	4.875	5.750	10.625	8.34	9.84	18.18
24-Jun-91	4.875	5.750	10.625	8.34	9.84	18.18
01-Jul-91	5.000	6.313	11.313	8.56	10.80	19.36
08-Jul-91	5.000	6.000	11.000	8.56	10.27	18.82
12-Jul-91	5.000	6.125	11.125	8.56	10.48	19.04
16-Jul-91	5.000	6.250	11.250	8.56	10.70	19.25
19-Jul-91	5.250	6.125	11.375	8.98	10.48	19.47
22-Jul-91	5.438	6.125	11.563	9.30	10.48	19.79
26-Jul-91	5.500	6.125	11.625	9.41	10.48	19.89
29-Jul-91	5.500	6.125	11.625	9.41	10.48	19.89
02-Aug-91	5.500	6.125	11.625	9.41	10.48	19.89
05-Aug-91	5.500	6.188	11.688	9.41	10.59	20.00
12-Aug-91	5.625	6.125	11.750	9.63	10.48	20.11
16-Aug-91	5.500	6.250	11.750	9.41	10.70	20.11
20-Aug-91	5.375	6.375	11.750	9.20	10.91	20.11
26-Aug-91	5.500	6.250	11.750	9.41	10.70	20.11
30-Aug-91	6.000	6.500	12.500	10.27	11.12	21.39
04-Sep-91	6.000	6.563	12.563	10.27	11.23	21.50
06-Sep-91	6.000	6.500	12.500	10.27	11.12	21.39
10-Sep-91	6.000	6.500	12.500	10.27	11.12	21.39
13-Sep-91	6.000	6.500	12.500	10.27	11.12	21.39
20-Sep-91	5.000	7.625	12.625	8.56	13.05	21.60
24-Sep-91	6.000	6.750	12.750	10.27	11.55	21.82
30-Sep-91	5.875	6.750	12.625	10.05	11.55	21.60

TABLE 5
PACIFIC NORTHERN OIL
TERMINAL 91

PNO NORTH DRUM CAPACITY READINGS

Date	Inches Water	Inches Product	Inches Total	Gallons Water	Gallons Product	Gallons Total
02-Oct-91	6.250	6.438	12.688	10.70	11.02	21.71
16-Oct-91	6.375	6.375	12.750	10.91	10.91	21.82
18-Oct-91	5.875	6.750	12.625	10.05	11.55	21.60
21-Oct-91	6.500	6.500	13.000	11.12	11.12	22.25
25-Oct-91	6.000	6.750	12.750	10.27	11.55	21.82
28-Oct-91	5.375	7.375	12.750	9.20	12.62	21.82
16-Nov-91	6.063	6.750	12.813	10.38	11.55	21.93
12-Nov-91	6.063	6.750	12.813	10.38	11.55	21.93
18-Nov-91	6.000	6.875	12.875	10.27	11.76	22.03
22-Nov-91	6.000	6.875	12.875	10.27	11.76	22.03
25-Nov-91	5.500	7.375	12.875	9.41	12.62	22.03
27-Nov-91	6.000	6.875	12.875	10.27	11.76	22.03
03-Dec-91	6.000	6.875	12.875	10.27	11.76	22.03
09-Dec-91	6.250	6.625	12.875	10.70	11.34	22.03
13-Dec-91	5.688	7.187	12.875	9.73	12.30	22.03
16-Dec-91	5.625	7.250	12.875	9.63	12.41	22.03
24-Dec-91	6.250	6.750	13.000	10.70	11.55	22.25
27-Dec-91	6.125	6.875	13.000	10.48	11.76	22.25
30-Dec-91	6.000	7.000	13.000	10.27	11.98	22.25
03-Jan-92	5.875	8.188	14.063	10.05	14.01	24.06
06-Jan-92	6.875	7.188	14.063	11.76	12.30	24.06
10-Jan-92	6.125	7.875	14.000	10.48	13.48	23.96
13-Jan-92	7.000	7.000	14.000	11.98	11.98	23.96
24-Jan-92	6.938	7.312	14.250	11.87	12.51	24.38
27-Jan-92	6.625	7.500	14.125	11.34	12.83	24.17
03-Feb-92	7.000	7.000	14.000	11.98	11.98	23.96

TABLE 6
PACIFIC NORTHERN OIL
TERMINAL 91

PNO SOUTH DRUM CAPACITY READINGS

Date	Inches Water	Inches Product	Inches Total	Gallons Water	Gallons Product	Gallons Total
29-Apr-91	1.000	3.500	4.500	1.71	5.99	7.70
01-May-91	4.500	6.000	10.500	7.70	10.27	17.97
03-May-91	4.750	4.250	9.000	8.13	7.27	15.40
06-May-91	4.750	3.750	8.500	8.13	6.42	14.55
08-May-91	4.750	3.750	8.500	8.13	6.42	14.55
10-May-91	4.750	3.750	8.500	8.13	6.42	14.55
12-May-91	4.500	4.000	8.500	7.70	6.84	14.55
16-May-91	4.750	3.750	8.500	8.13	6.42	14.55
20-May-91	4.500	4.000	8.500	7.70	6.84	14.55
21-May-91	4.875	4.000	8.875	8.34	6.84	15.19
28-May-91	5.000	4.000	9.000	8.56	6.84	15.40
31-May-91	4.000	6.250	10.250	6.84	10.70	17.54
21-Jun-91	4.250	4.750	9.000	7.27	8.13	15.40
24-Jun-91	4.500	4.750	9.250	7.70	8.13	15.83
01-Jul-91	4.875	4.875	9.750	8.34	8.34	16.68
08-Jul-91	5.250	4.750	10.000	8.98	8.13	17.11
12-Jul-91	5.125	4.875	10.000	8.77	8.34	17.11
16-Jul-91	5.500	4.875	10.375	9.41	8.34	17.75
19-Jul-91	5.500	5.125	10.625	9.41	8.77	18.18
22-Jul-91	6.250	5.000	11.250	10.70	8.56	19.25
26-Jul-91	5.625	5.625	11.250	9.63	9.63	19.25
29-Jul-91	5.625	5.875	11.500	9.63	10.05	19.68
02-Aug-91	6.188	5.313	11.500	10.59	9.09	19.68
05-Aug-91	6.000	5.625	11.625	10.27	9.63	19.89
12-Aug-91	5.875	5.875	11.750	10.05	10.05	20.11
16-Aug-91	6.000	5.625	11.625	10.27	9.63	19.89
20-Aug-91	6.250	5.750	12.000	10.70	9.84	20.53
26-Aug-91	6.000	5.875	11.875	10.27	10.05	20.32
30-Aug-91	7.250	6.125	13.375	12.41	10.48	22.89
04-Sep-91	7.375	5.938	13.313	12.62	10.16	22.78
06-Sep-91	6.875	6.500	13.375	11.76	11.12	22.89
10-Sep-91	6.500	7.000	13.500	11.12	11.98	23.10
13-Sep-91	6.500	7.000	13.500	11.12	11.98	23.10
20-Sep-91	6.750	7.125	13.875	11.55	12.19	23.74
24-Sep-91	6.750	7.250	14.000	11.55	12.41	23.96
30-Sep-91	7.375	6.875	14.250	12.62	11.76	24.38

TABLE 6
PACIFIC NORTHERN OIL
TERMINAL 91

PNO SOUTH DRUM CAPACITY READINGS

Date	Inches Water	Inches Product	Inches Total	Gallons Water	Gallons Product	Gallons Total
02-Oct-91	7.125	7.063	14.188	12.19	12.09	24.28
16-Oct-91	7.250	7.250	14.500	12.41	12.41	24.81
18-Oct-91	7.500	7.375	14.875	12.83	12.62	25.45
21-Oct-91	7.250	8.000	15.250	12.41	13.69	26.10
25-Oct-91	7.375	7.625	15.000	12.62	13.05	25.67
28-Oct-91	7.500	7.813	15.313	12.83	13.37	26.20
06-Nov-91	7.625	7.938	15.563	13.05	13.58	26.63
12-Nov-91	8.000	7.813	15.813	13.69	13.37	27.06
18-Nov-91	7.625	8.313	15.938	13.05	14.23	27.27
22-Nov-91	7.500	8.563	16.063	12.83	14.65	27.49
25-Nov-91	7.813	8.250	16.063	13.37	14.12	27.49
27-Nov-91	7.813	8.187	16.000	13.37	14.01	27.38
03-Dec-91	7.500	8.500	16.000	12.83	14.55	27.38
09-Dec-91	7.500	8.625	16.125	12.83	14.76	27.59
13-Dec-91	8.000	8.125	16.125	13.69	13.90	27.59
16-Dec-91	7.500	8.438	15.938	12.83	14.44	27.27
24-Dec-91	7.500	8.625	16.125	12.83	14.76	27.59
27-Dec-91	8.125	8.063	16.188	13.90	13.80	27.70
30-Dec-91	7.688	8.562	16.250	13.16	14.65	27.81
03-Jan-92	8.000	10.500	18.500	13.69	17.97	31.66
06-Jan-92	9.813	8.750	18.563	16.79	14.97	31.77
10-Jan-92	10.250	7.750	18.000	17.54	13.26	30.80
13-Jan-92	7.000	10.875	17.875	11.98	18.61	30.59
24-Jan-92	9.563	8.937	18.500	16.36	15.29	31.66
27-Jan-92	10.000	8.375	18.375	17.11	14.33	31.44
03-Feb-92	8.750	9.625	18.375	14.97	16.47	31.44

TABLE 7

PACIFIC NORTHERN OIL PIER 91 DIESEL LINE BREAK SITE DAILY EFFLUENT DISCHARGE RECORDS					
DATE	TIME	TOTALIZER (GALLONS)	DAILY TOTAL (GALLONS)	AVERAGE GPM	COMMENTS
01/08/91	13:08	671	671	--	
01/09/91	12:31	867	196	0.14	
01/15/91	13:42	931	64	0.01	
01/16/91	14:20	1222	291	0.20	
01/17/91	14:53	1851	629	0.43	
01/18/91	13:00	3030	1179	0.89	
01/21/91	06:30	5759	2729	0.69	
01/22/91	09:02	6269	510	0.32	
01/23/91	11:35	6560	291	0.18	
01/24/91	07:30	6600	40	0.03	
01/25/91	13:26	6762	162	0.09	
01/28/91	12:21	6969	207	0.05	
01/29/91	12:24	7059	90	0.06	
01/30/91	14:22	7160	101	0.06	
01/31/91	12:50	7206	46	0.03	
02/01/91	12:31	7209	3	0.00	
02/04/91	13:08	7288	79	0.02	
02/05/91	13:33	7297	9	0.01	SYSTEM DOWN; AIR COMPRESSOR
02/19/91	14:30	7297	0	0.00	FILTER FAILED
02/21/91	10:50	9303	2006	0.75	
02/22/91	08:55	9772	469	0.35	
02/25/91	12:18	10715	943	0.21	
02/27/91	14:06	11112	397	0.13	
03/01/91	14:50	11683	571	0.20	
03/05/91	09:30	13720	2037	0.37	
03/07/91	09:30	14784	1064	0.37	
03/08/91	10:30	15204	420	0.28	
03/11/91	16:56	16292	1088	0.23	SYSTEM DOWN. ADJUST DRAIN LEVEL
03/12/91	17:14	16292	0	0.00	IN O/W SEPARATOR
03/13/91	13:22	16292	0	0.00	
03/14/91	13:40	16293	1	0.00	
03/15/91	17:03	16326	33	0.02	SYSTEM UP
03/18/91	16:42	16993	667	0.16	
03/19/91	14:30	17299	306	0.23	
03/20/91	12:56	17421	122	0.09	

TABLE 7

PACIFIC NORTHERN OIL PIER 91 DIESEL LINE BREAK SITE DAILY EFFLUENT DISCHARGE RECORDS					
DATE	TIME	TOTALIZER (GALLONS)	DAILY TOTAL (GALLONS)	AVERAGE GPM	COMMENTS
03/21/91	13:35	17811	390	0.26	
03/22/91	13:31	18124	313	0.22	
03/25/91	16:48	18465	341	0.08	
03/26/91	17:30	18767	302	0.20	
03/27/91	14:08	18868	101	0.08	
04/02/91	06:50	19957	1089	0.13	
04/03/91	07:00	19957	0	0.00	SYSTEM DOWN. RECALIBRATE MSA
04/15/91	07:00	19957	0	0.00	TO PROPANE
04/17/91	14:30	20137	180	0.05	SYSTEM UP
04/18/91	06:50	20181	44	0.04	
04/19/91	06:55	20540	359	0.25	
04/22/91	06:50	20556	16	0.00	
04/23/91	06:50	21298	742	0.52	
04/24/91	06:55	21593	295	0.20	
04/25/91	06:50	21599	6	0.00	
04/26/91	06:55	21793	194	0.13	
04/29/91	06:55	22370	577	0.13	
04/30/91	06:56	23205	835	0.58	
05/01/91	06:55	23551	346	0.24	
05/02/91	07:00	23605	54	0.04	
05/06/91	06:55	23694	89	0.02	
05/07/91	06:50	23809	115	0.08	
05/08/91	06:55	23815	6	0.00	
05/09/91	06:50	24819	1004	0.70	
05/10/91	07:00	24826	7	0.00	
05/13/91	06:45	24969	143	0.03	
05/14/91	06:40	25073	104	0.07	
05/16/91	06:45	25426	353	0.12	
05/17/91	13:55	25922	496	0.27	
05/20/91	06:55	25931	9	0.00	
05/21/91	07:05	26010	79	0.05	
05/22/91	06:50	27337	1327	0.93	
05/23/91	06:45	28519	1182	0.82	
05/24/91	06:45	29614	1095	0.76	
05/28/91	06:45	33757	4143	0.72	

TABLE 7

PACIFIC NORTHERN OIL PIER 91 DIESEL LINE BREAK SITE DAILY EFFLUENT DISCHARGE RECORDS					
DATE	TIME	TOTALIZER (GALLONS)	DAILY TOTAL (GALLONS)	AVERAGE GPM	COMMENTS
05/29/91	06:40	34938	1181	0.82	
05/30/91	06:55	36322	1384	0.95	
05/31/91	06:40	37622	1300	0.91	
06/03/91	06:55	41521	3899	0.90	
06/05/91	06:50	41541	20	0.01	
06/06/91	06:50	41541	0	0.00	SYSTEM DOWN. COMPRESSOR FAILED
06/22/91	17:00	41605	64	0.00	SYSTEM UP. REPLACE COMPRESSOR
06/24/91	10:22	41605	0	0.00	
07/01/91	10:03	41605	0	0.00	
07/05/91	09:28	41605	0	0.00	
07/08/91	10:21	41806	201	0.05	
07/12/91	07:41	41837	31	0.01	
07/16/91	09:25	41991	154	0.03	
07/19/91	06:55	42216	225	0.05	
07/22/91	06:55	42249	33	0.01	
07/23/91	06:50	42340	91	0.06	
07/24/91	06:55	42381	41	0.03	
07/25/91	07:00	42470	89	0.06	
07/26/91	09:08	42556	86	0.05	
07/29/91	08:18	42791	235	0.06	
08/02/91	12:38	42891	100	0.02	
08/05/91	13:35	43032	141	0.03	
08/12/91	07:00	43173	141	0.01	
08/13/91	06:53	43173	0	0.00	
08/14/91	06:59	43182	9	0.01	
08/16/91	06:50	43182	0	0.00	
08/19/91	06:58	43358	176	0.04	
08/20/91	10:29	43440	258	0.04	
08/21/91	06:55	43481	41	0.03	
08/22/91	07:00	43570	89	0.06	
08/26/91	08:20	43803	233	0.04	
08/27/91	07:00	43811	8	0.01	
08/28/91	06:55	43870	59	0.04	
08/29/91	06:58	43909	39	0.03	
08/30/91	11:00	43951	148	0.03	

TABLE 7

PACIFIC NORTHERN OIL PIER 91 DIESEL LINE BREAK SITE DAILY EFFLUENT DISCHARGE RECORDS					
DATE	TIME	TOTALIZER (GALLONS)	DAILY TOTAL (GALLONS)	AVERAGE GPM	COMMENTS
09/03/91	06:52	43970	19	0.00	
09/04/91	09:09	43980	10	0.01	
09/05/91	06:55	44018	38	0.03	
09/06/91	06:50	44046	28	0.02	
09/09/91	06:50	44075	29	0.01	
09/10/91	06:55	44075	0	0.00	
09/11/91	06:55	44075	0	0.00	
09/12/91	06:55	44075	0	0.00	
09/14/91	06:55	44075	0	0.00	
09/16/91	06:50	44178	103	0.01	
09/30/91	06:50	44178	0	0.00	SYSTEM DOWN; BROKEN COMPRES. HOSE
10/01/91	06:55	44184	6	0.00	
10/02/91	06:40	44192	8	0.01	
10/03/91	06:55	44192	0	0.00	
10/04/91	06:50	44192	0	0.00	
10/07/91	13:33	44212	20	0.00	
10/09/91	15:37	44212	0	0.00	
10/11/91	15:07	44212	0	0.00	
10/16/91	12:26	44226	14	0.00	
10/17/91	07:05	44281	55	0.05	
10/18/91	09:00	44283	2	0.00	
10/21/91	14:20	44290	7	0.00	
10/22/91	07:50	44290	0	0.00	
10/23/91	06:58	44309	19	0.01	
10/24/91	07:00	44309	0	0.00	
10/25/91	06:50	44309	0	0.00	
10/28/91	06:55	44573	264	0.06	
10/29/91	06:52	44794	221	0.15	
10/30/91	06:55	44809	15	0.01	
10/31/91	06:50	44947	138	0.10	
11/01/91	06:55	45039	92	0.06	
11/04/91	06:57	45371	332	0.08	
11/05/91	06:53	45458	87	0.06	
11/06/91	06:55	45646	188	0.13	
11/07/91	06:50	45672	26	0.02	

TABLE 7

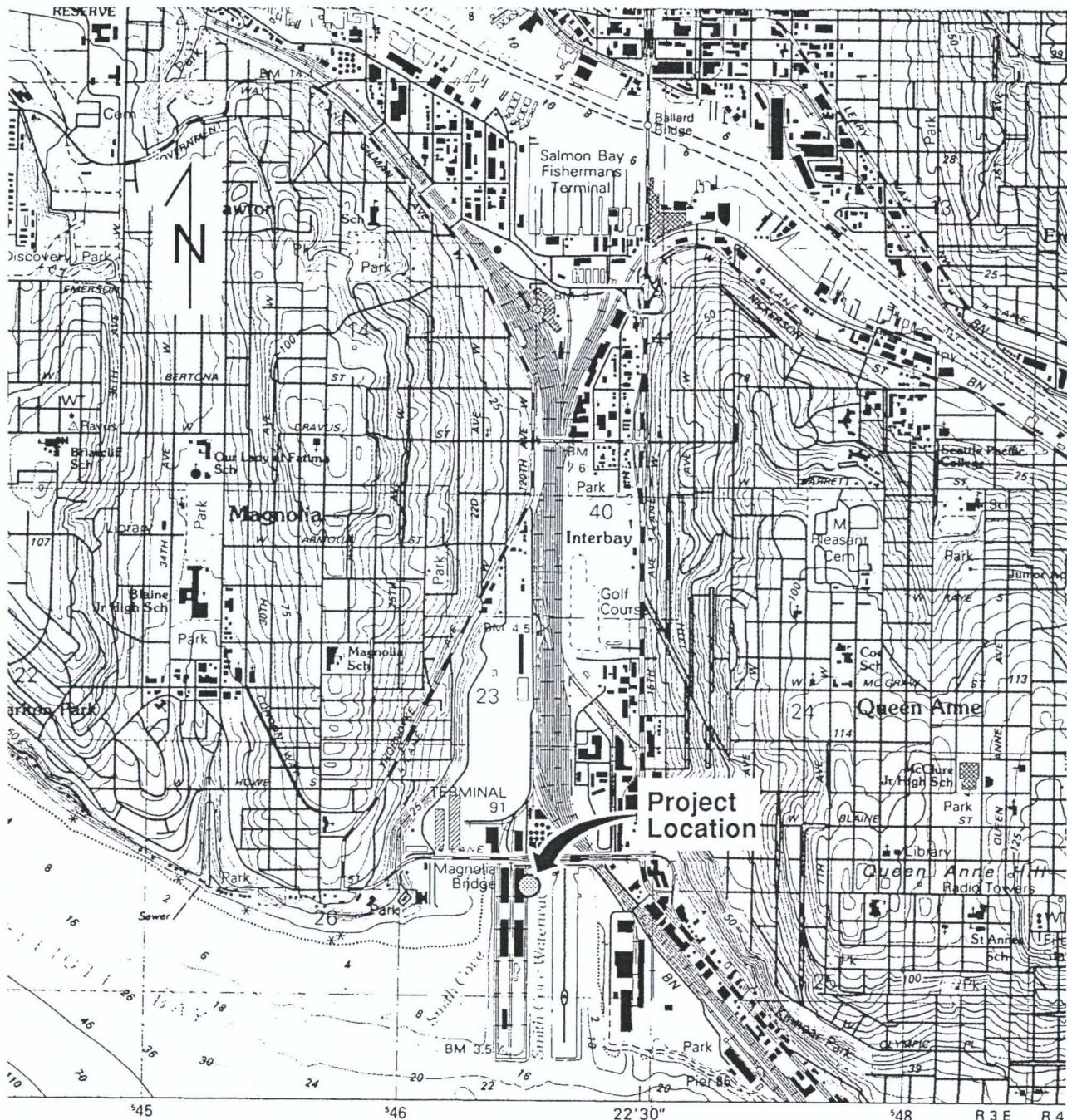
PACIFIC NORTHERN OIL PIER 91 DIESEL LINE BREAK SITE DAILY EFFLUENT DISCHARGE RECORDS					
DATE	TIME	TOTALIZER (GALLONS)	DAILY TOTAL (GALLONS)	AVERAGE GPM	COMMENTS
11/08/91	07:05	45696	24	0.02	
11/11/91	07:00	45720	24	0.01	
11/12/91	06:55	45744	24	0.02	
11/13/91	07:00	45768	24	0.02	
11/14/91	06:55	45792	24	0.02	
11/15/91	07:10	45816	24	0.02	INSTALLED NEW TIMER
11/22/91	10:30	45840	24	0.00	
11/25/91	10:54	45864	24	0.01	
11/27/91	10:32	45888	24	0.01	
11/28/91	07:00	45912	24	0.02	
11/29/91	06:50	45936	24	0.02	
11/30/91	06:50	45960	24	0.02	
12/02/91	06:50	45984	24	0.01	
12/03/91	06:50	46008	24	0.02	
12/04/91	06:50	46032	24	0.02	
12/05/91	06:50	46056	24	0.02	
12/09/91	06:50	46080	24	0.00	
12/10/91	06:50	46104	24	0.02	DISCHARGE FROM MEASURED FLOW RATE
12/11/91	06:50	46128	24	0.02	
12/12/91	06:50	46152	24	0.02	
12/13/91	06:50	46176	24	0.02	
12/14/91	06:50	46200	24	0.02	
12/15/91	06:50	46224	24	0.02	
12/16/91	06:50	46248	24	0.02	
12/17/91	06:50	46272	24	0.02	
12/18/91	06:50	46296	24	0.02	
12/19/91	06:50	46320	24	0.02	
12/20/91	06:50	46344	24	0.02	
12/21/91	06:50	46368	24	0.02	
12/22/91	06:50	46392	24	0.02	
12/23/91	06:50	46416	24	0.02	
12/24/91	06:50	46440	24	0.02	
12/25/91	06:50	46464	24	0.02	
12/26/91	06:50	46488	24	0.02	
12/27/91	06:50	46512	24	0.02	

TABLE 7

PACIFIC NORTHERN OIL PIER 91 DIESEL LINE BREAK SITE DAILY EFFLUENT DISCHARGE RECORDS					
DATE	TIME	TOTALIZER (GALLONS)	DAILY TOTAL (GALLONS)	AVERAGE GPM	COMMENTS
12/28/91	06:50	46536	24	0.02	
12/29/91	06:50	46560	24	0.02	
12/30/91	06:50	46584	24	0.02	
12/31/91	06:50	46608	24	0.02	
01/01/92	06:50	46628	20.2	0.01	VOLUMETRIC MEAS.=20.2 GAL/DAY
01/02/92	06:50	46648	20.2	0.01	
01/03/92	06:50	46669	20.2	0.01	
01/04/92	06:50	46689	20.2	0.01	
01/05/92	06:50	46709	20.2	0.01	
01/06/92	06:50	46729	20.2	0.01	
01/07/92	06:50	46749	20.2	0.01	
01/08/92	06:50	46770	20.2	0.01	
01/09/92	06:50	46790	20.2	0.01	
01/10/92	06:50	46810	20.2	0.01	
01/11/92	06:50	46830	20.2	0.01	
01/12/92	06:50	46850	20.2	0.01	
01/13/92	06:50	46871	20.2	0.01	
01/14/92	06:50	46891	20.2	0.01	
01/15/92	06:50	46911	20.2	0.01	
01/16/92	06:50	46931	20.2	0.01	
01/17/92	06:50	46951	20.2	0.01	
01/18/92	06:50	46990	38.4	0.03	
01/19/92	06:50	47028	38.4	0.03	
01/20/92	06:50	47067	38.4	0.03	
01/21/92	06:50	47105	38.4	0.03	
01/22/92	06:50	47143	38.4	0.03	
01/23/92	06:50	47182	38.4	0.03	
01/24/92	06:50	47220	38.4	0.03	
01/25/92	06:50	47259	38.4	0.03	
01/26/92	06:50	47297	38.4	0.03	
01/27/92	06:50	47335	38.4	0.03	
01/28/92	06:50	47374	38.4	0.03	
01/29/92	06:50	47412	38.4	0.03	
01/30/92	06:50	47451	38.4	0.03	
01/31/92	06:50	47489	38.4	0.03	

TABLE 7

PACIFIC NORTHERN OIL PIER 91 DIESEL LINE BREAK SITE DAILY EFFLUENT DISCHARGE RECORDS					
DATE	TIME	TOTALIZER (GALLONS)	DAILY TOTAL (GALLONS)	AVERAGE GPM	COMMENTS
02/01/92	06:50	47527	38.4	0.03	
02/02/92	06:50	47566	38.4	0.03	
02/03/92	06:50	47604	38.4	0.03	
02/04/92	06:50	47643	38.4	0.03	
02/05/92	06:50	47681	38.4	0.03	
02/06/92	06:50	47719	38.4	0.03	
02/07/92	06:50	47758	38.4	0.03	



Reference: Seattle North. 7.5'x15' Quadrangle.
U.S.G.S. and N.O.S. 1983.

Scale



PROJECT LOCATION MAP

INTERIM LIQUID HYDROCARBON EXTRACTION SYSTEM
ANNUAL PROGRESS REPORT

Seattle, Washington
for Pacific Northern Oil

Project No.

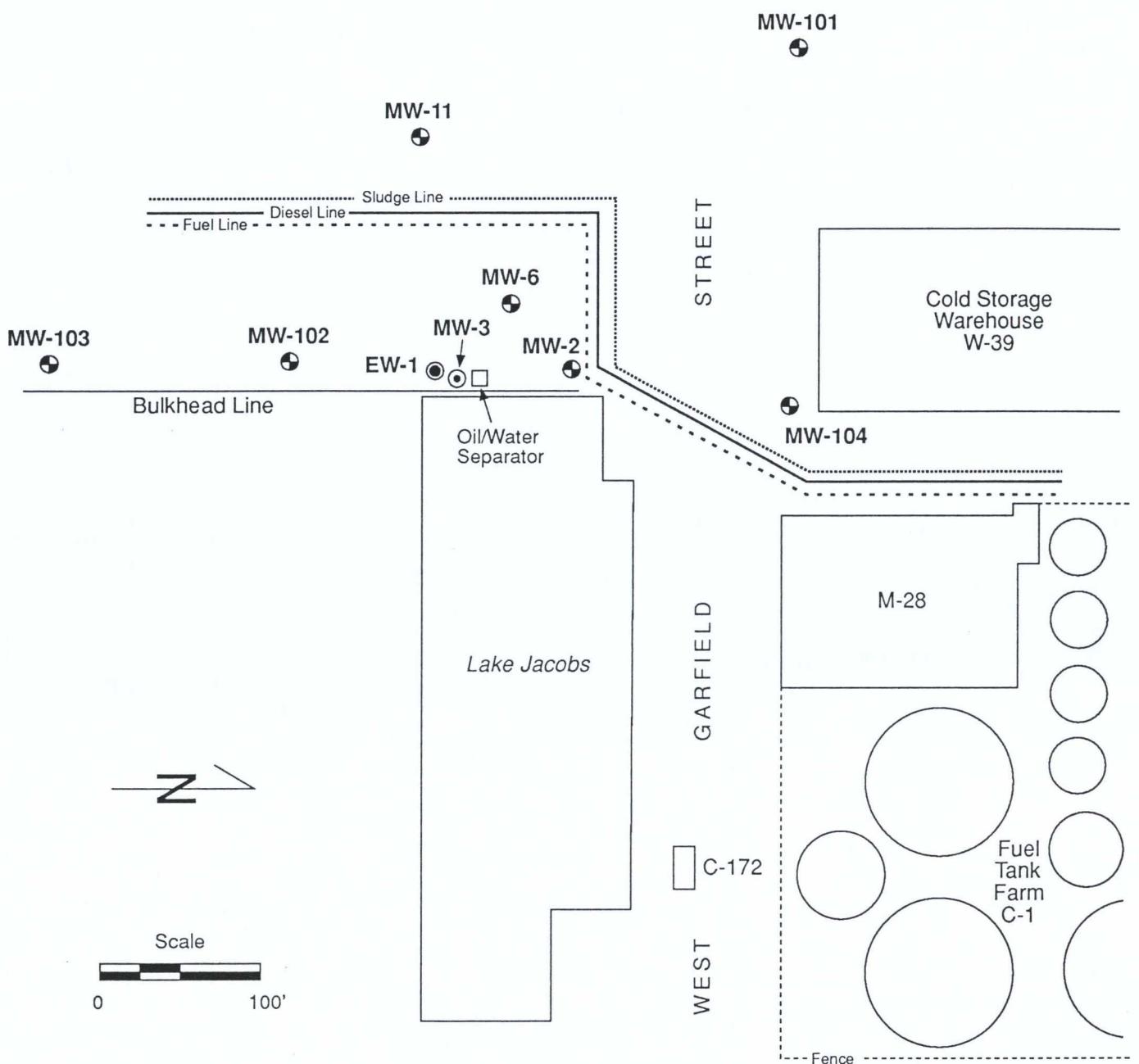
89-45527-04

Figure No.

1



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- Approved for publication by _____
- Monitoring Well
 - 6" Diameter Liquid Hydrocarbon Recovery Well
 - ◎ 2" Diameter Liquid Hydrocarbon Recovery Well

SITE LAYOUT AND MONITORING WELL LOCATION MAP

INTERIM LIQUID HYDROCARBON EXTRACTION SYSTEM
ANNUAL PROGRESS REPORT
Seattle, Washington
for Pacific Northern Oil

Project No.

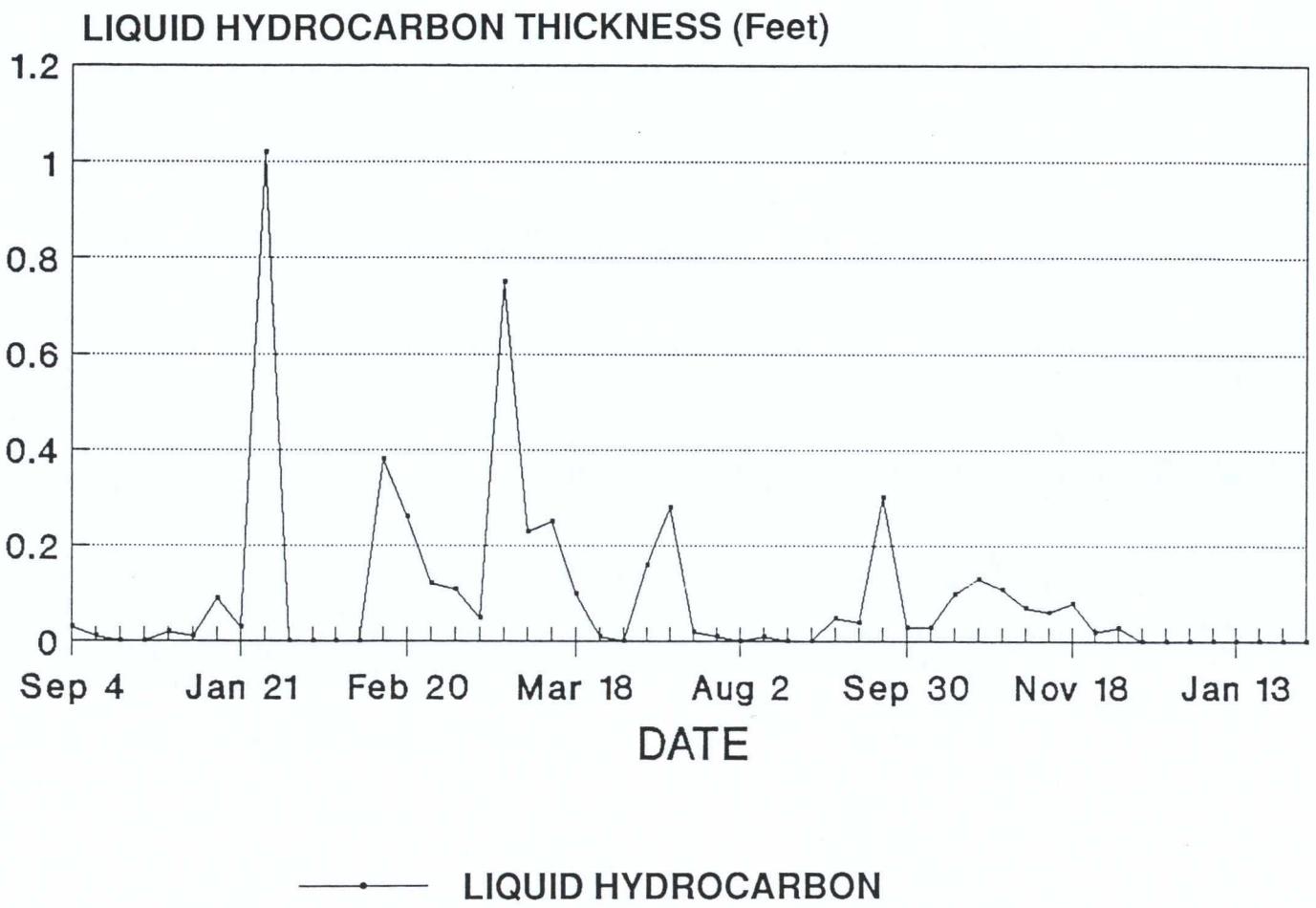
89-45527-04

Figure No.

2



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PNO EXTRACTION WELL EW-1 LIQUID HYDROCARBON THICKNESS

INTERIM LIQUID HYDROCARBON EXTRACTION SYSTEM
ANNUAL PROGRESS REPORT
Seattle, Washington
for Pacific Northern Oil

Project No.

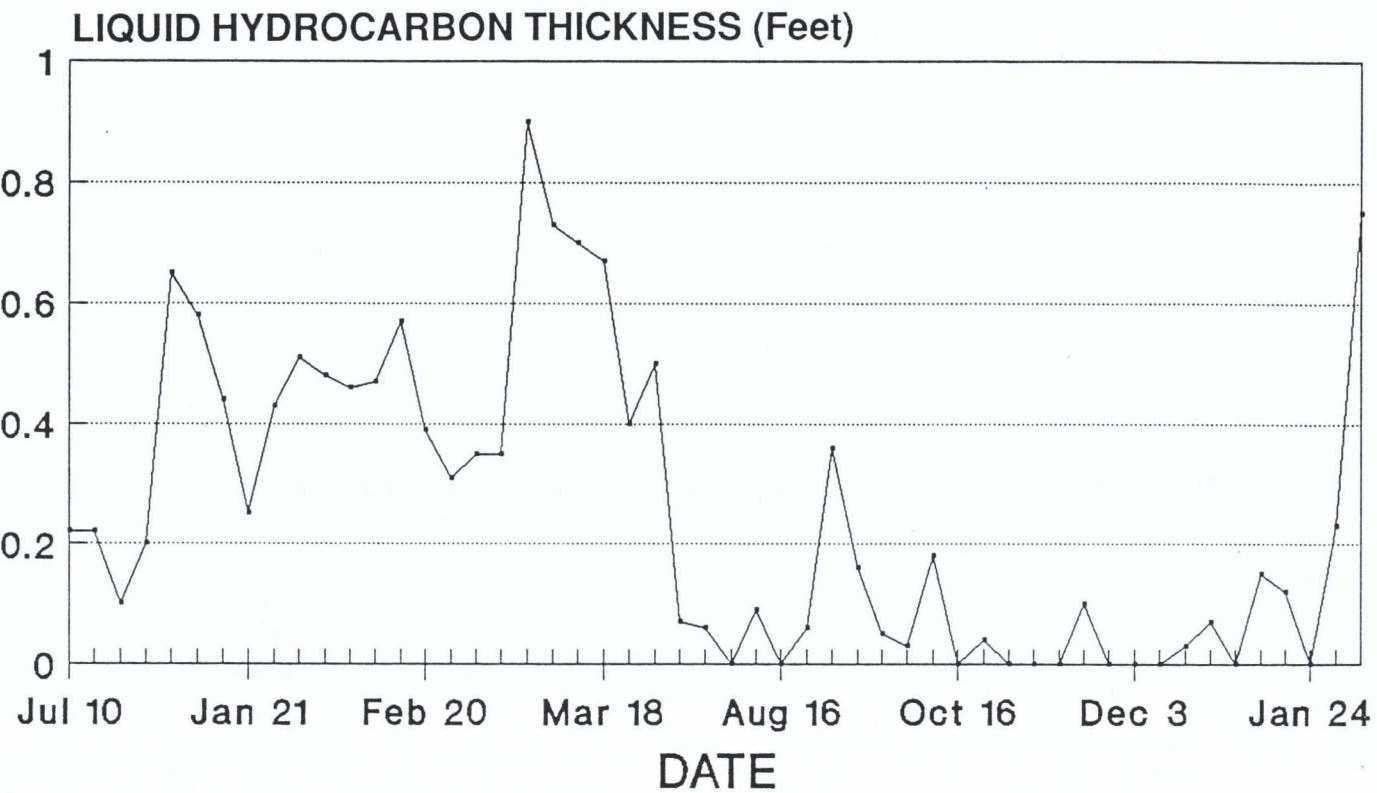
89-45527-04

Figure No.

3



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— LIQUID HYDROCARBON

PNO MONITORING WELL MW-3 LIQUID HYDROCARBON THICKNESS

INTERIM LIQUID HYDROCARBON EXTRACTION SYSTEM
ANNUAL PROGRESS REPORT
Seattle, Washington
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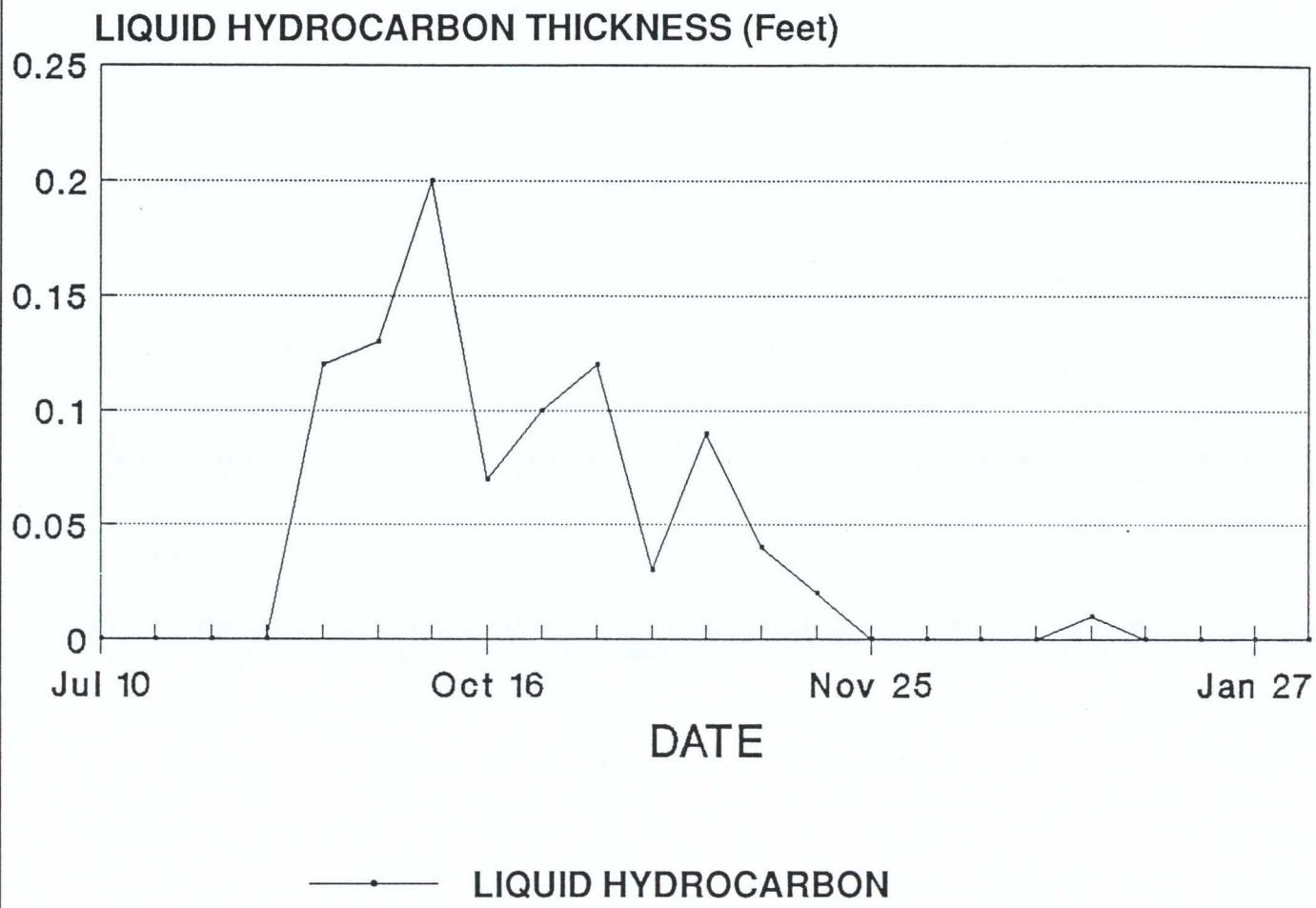
Project No.
89-45527-04

Figure No.

4



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PNO MONITORING WELL MW-102 LIQUID HYDROCARBON THICKNESS

INTERIM LIQUID HYDROCARBON EXTRACTION SYSTEM
ANNUAL PROGRESS REPORT
Seattle, Washington
for Pacific Northern Oil

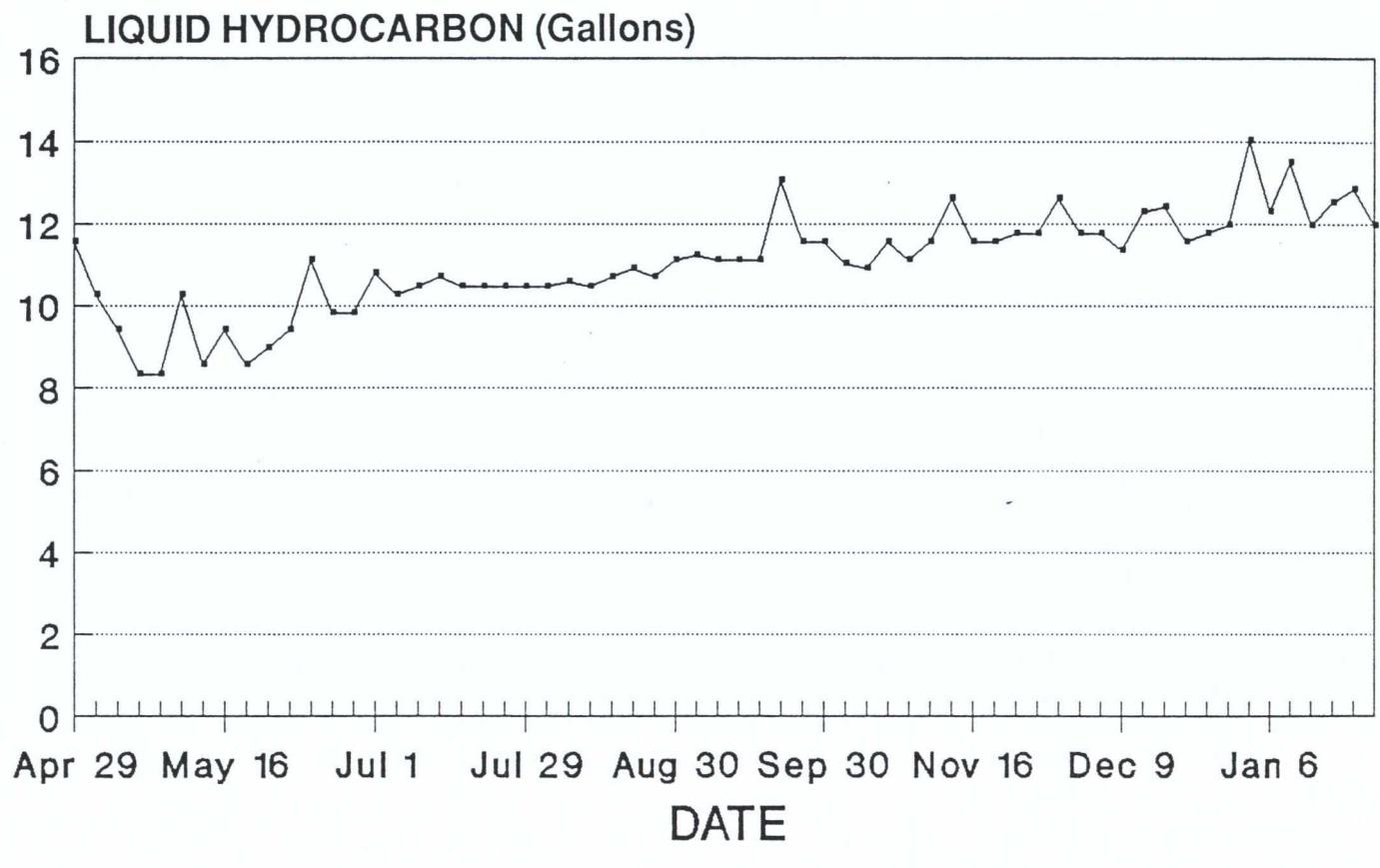
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89-45527-04

Figure No.

5



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by _____
Approved for publication

PNO NORTH DRUM LIQUID HYDROCARBON VOLUME

INTERIM LIQUID HYDROCARBON EXTRACTION SYSTEM
ANNUAL PROGRESS REPORT
Seattle, Washington
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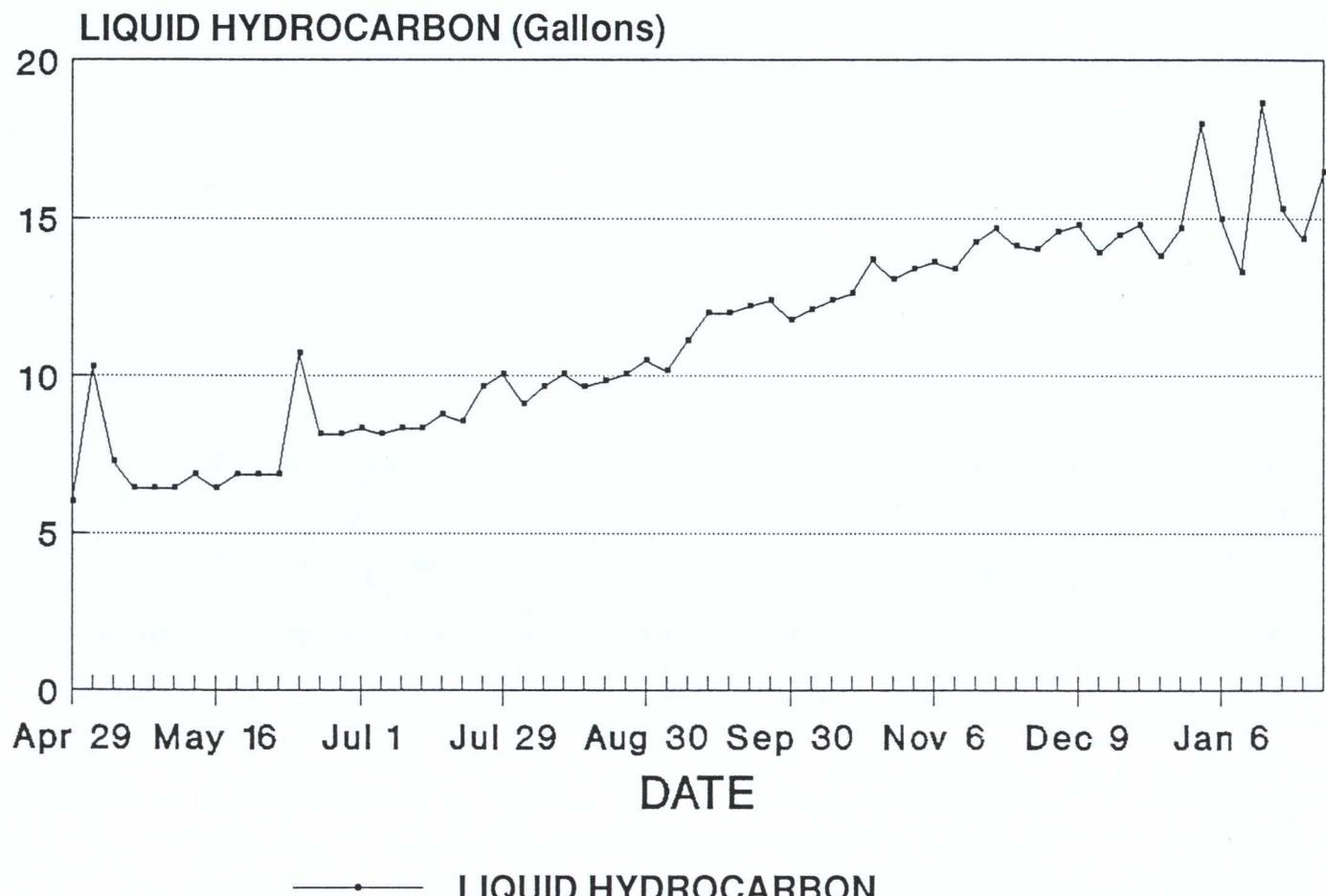
Project No.
89-45527-04

Figure No.

6



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PNO SOUTH DRUM LIQUID HYDROCARBON VOLUME

INTERIM LIQUID HYDROCARBON EXTRACTION SYSTEM
ANNUAL PROGRESS REPORT
Seattle, Washington
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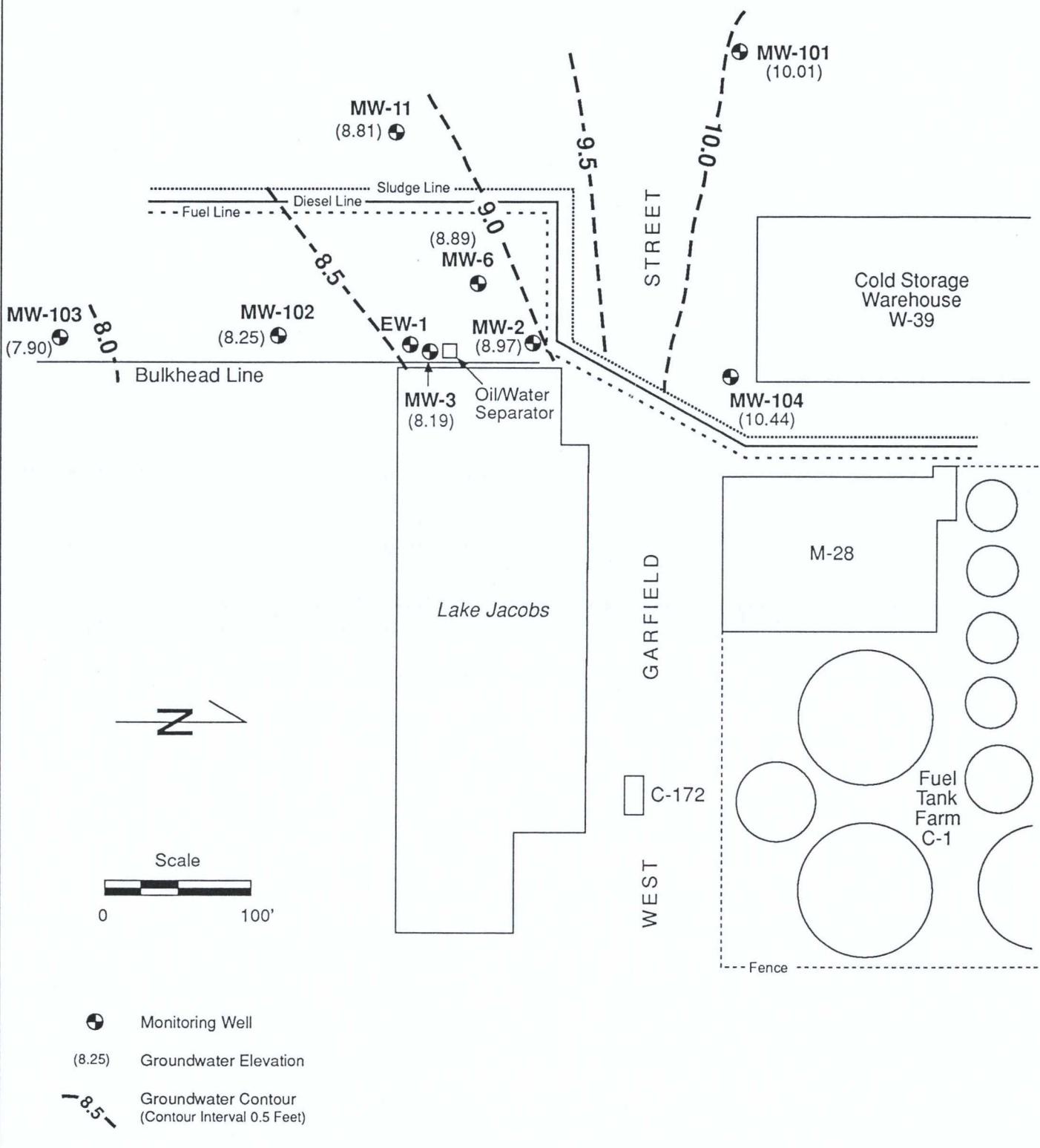
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Figure No.

7



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GROUNDWATER ELEVATION—JULY 11, 1990

INTERIM LIQUID HYDROCARBON EXTRACTION SYSTEM
ANNUAL PROGRESS REPORT
Seattle, Washington
for Pacific Northern Oil

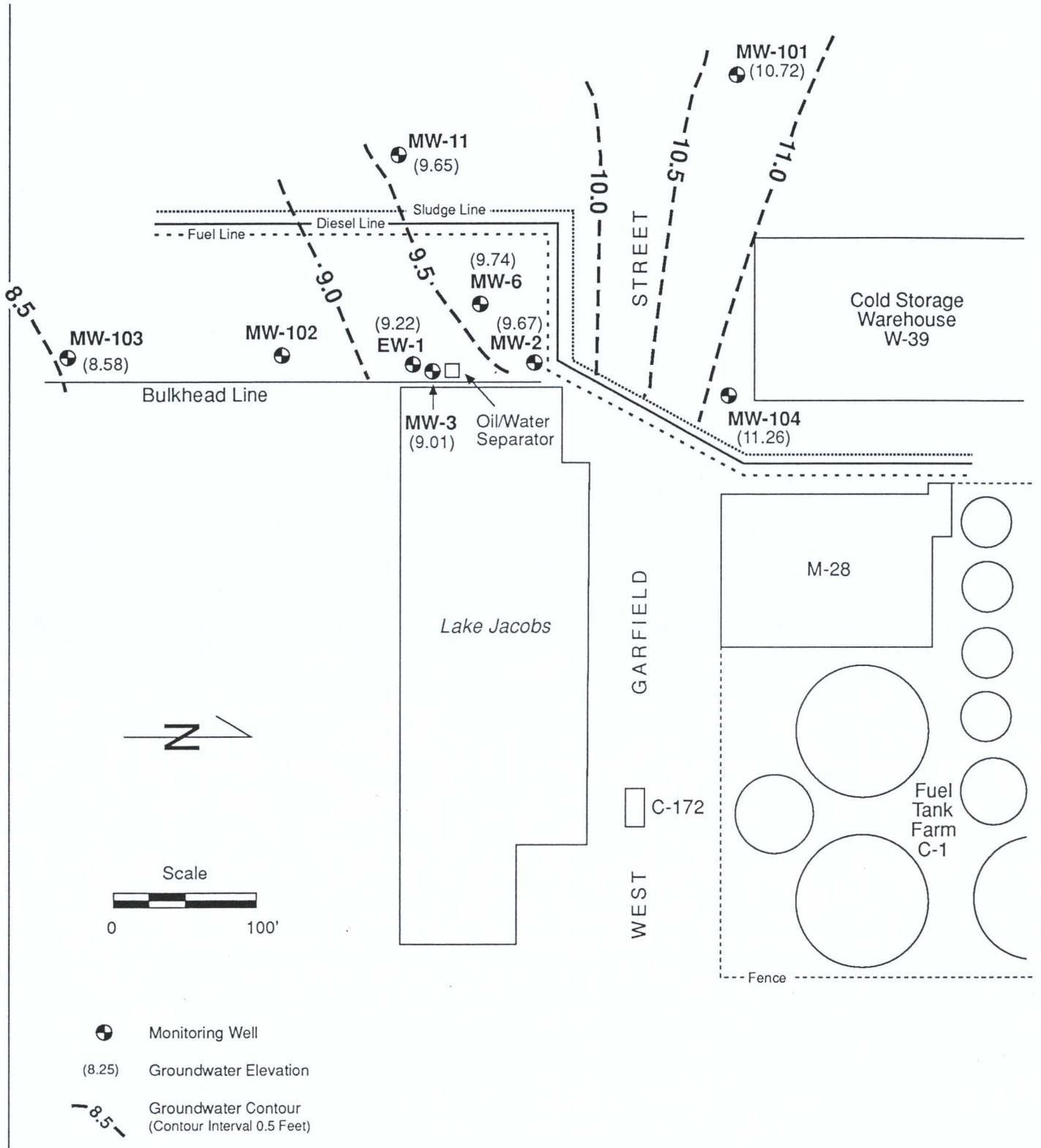
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89-45527-04



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Figure No.

8



GROUNDWATER ELEVATION—DECEMBER 6, 1990

INTERIM LIQUID HYDROCARBON EXTRACTION SYSTEM
ANNUAL PROGRESS REPORT
Seattle, Washington
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Project No.

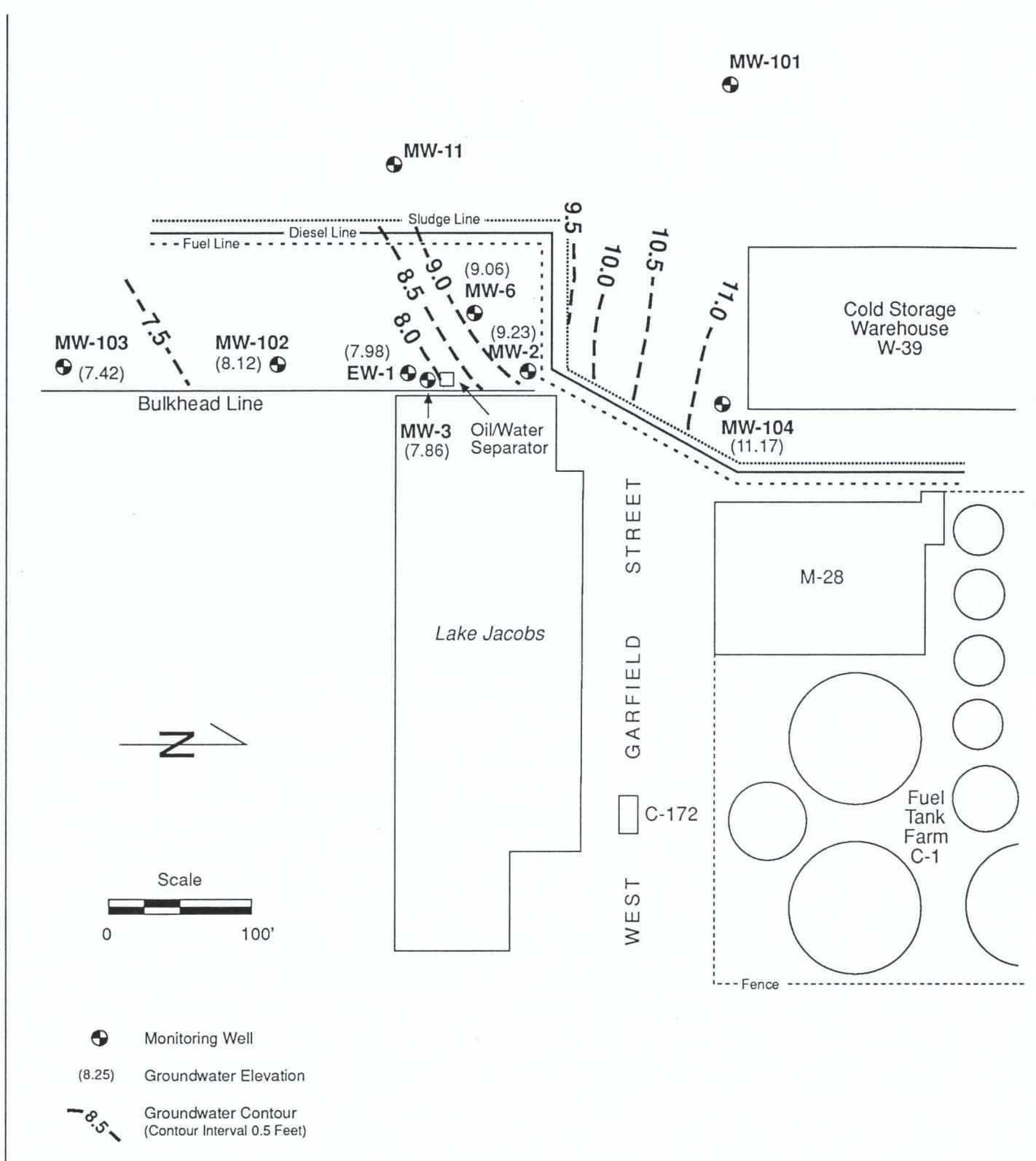
89-45527-04

Figure No.

9



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GROUNDWATER ELEVATION—APRIL 30, 1991

INTERIM LIQUID HYDROCARBON EXTRACTION SYSTEM
ANNUAL PROGRESS REPORT

Seattle, Washington
for Pacific Northern Oil

Project No.

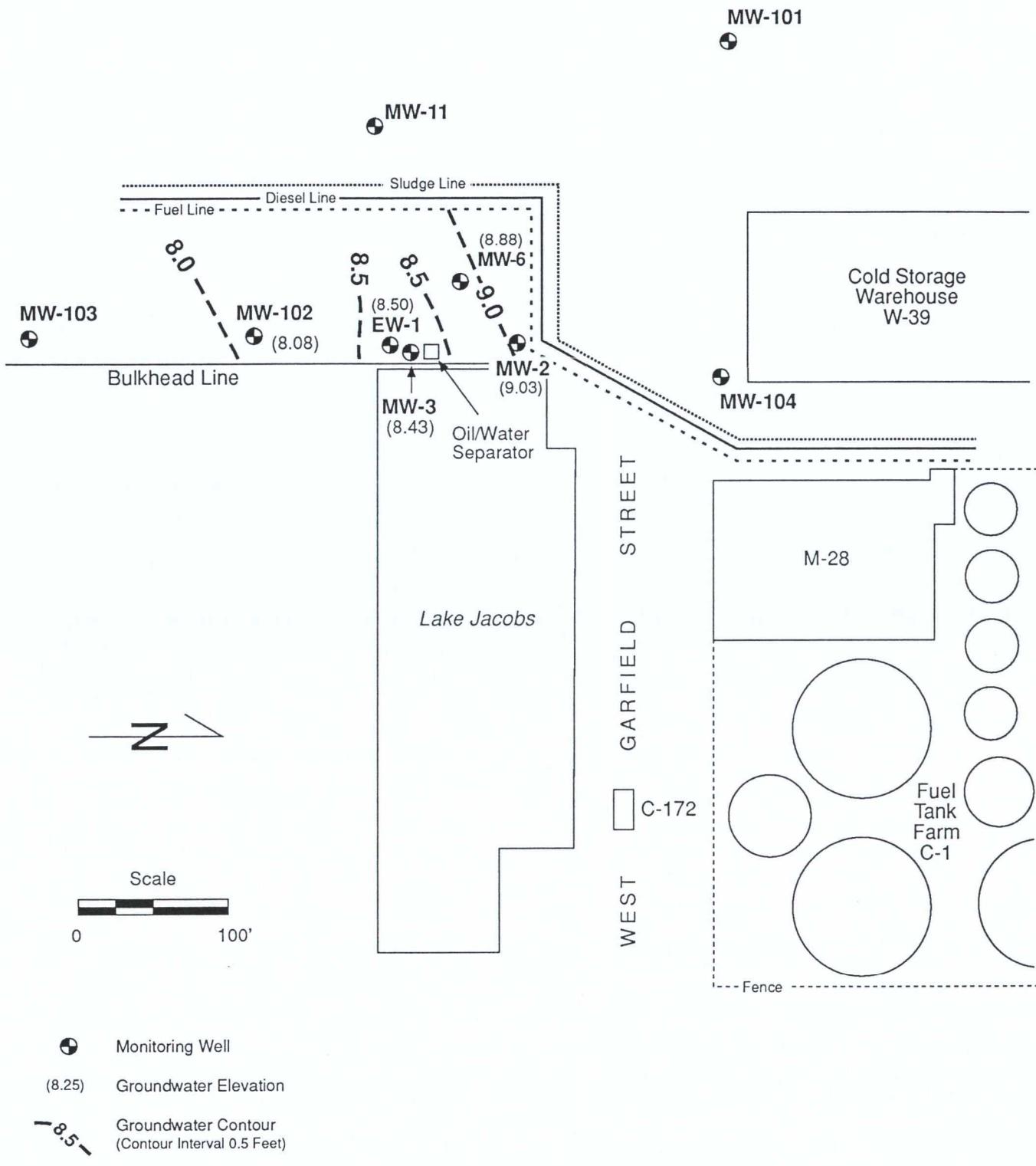
89-45527-04

Figure No.

10



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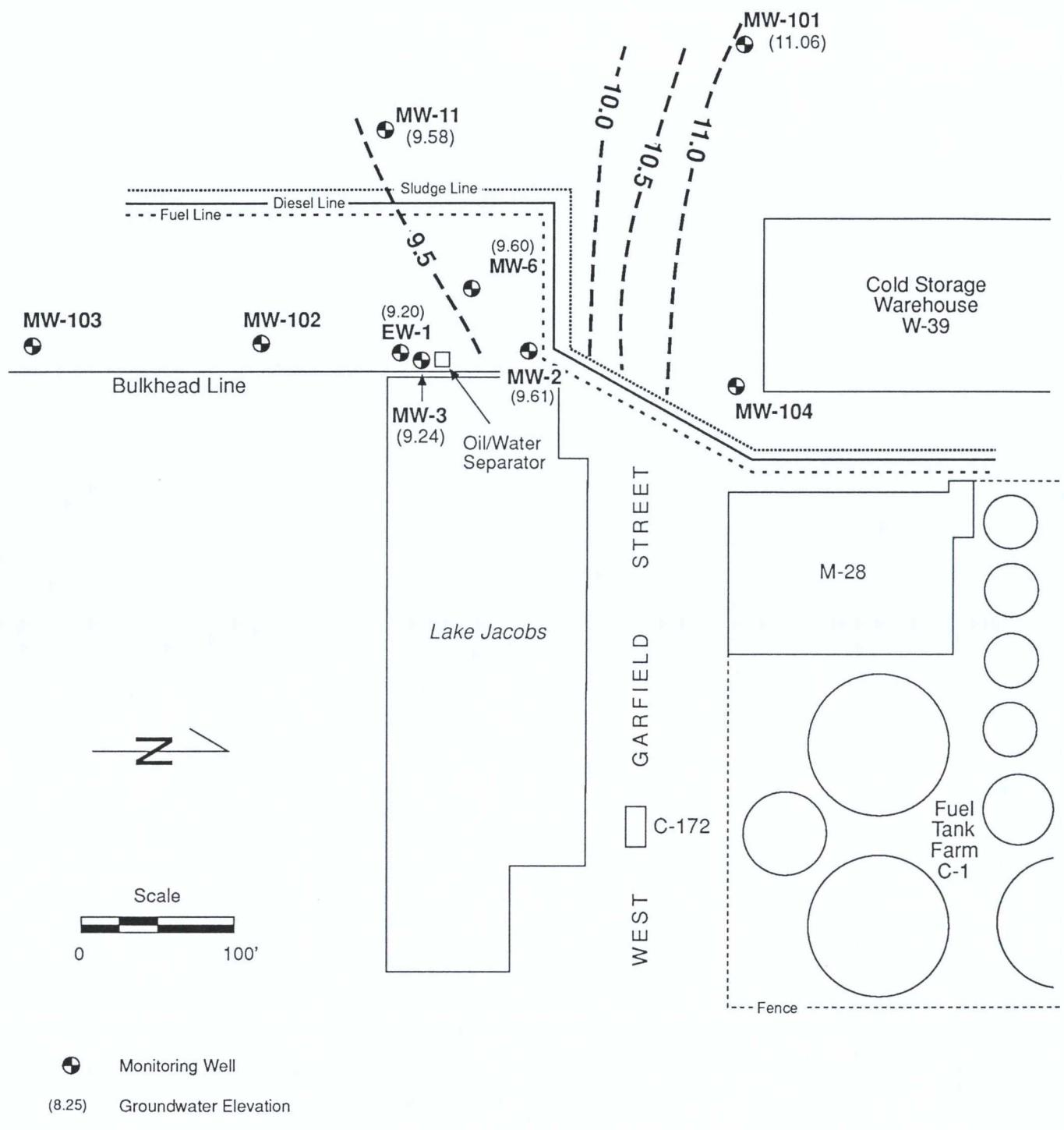
GROUNDWATER ELEVATION–AUGUST 29, 1991

INTERIM LIQUID HYDROCARBON EXTRACTION SYSTEM
ANNUAL PROGRESS REPORT
Seattle, Washington
for Pacific Northern Oil

Project No.

89-45527-04

Figure No.



GROUNDWATER ELEVATION—JANUARY 2, 1992

INTERIM LIQUID HYDROCARBON EXTRACTION SYSTEM
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Figure No.

12



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